Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.6, No.22, 2015
www.iiste.org

Technical Efficiency of Small Beef Cattle-Fattening Production in Muaro Jambi District, Jambi Province Indonesia

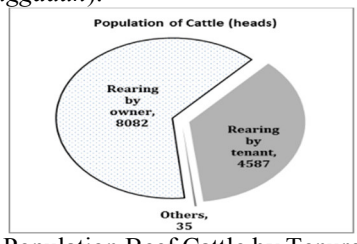
Bagus Pramusintho[1] Slamet Hartono[2] Any Suryantini[2] Dwidjono Hadi Darwanto[2]
1.Department of Animal Production, Faculty of Animal Science, Jambi University, Indonesia
2.Department of Agricultural Economics, Faculty of Agriculture, Gadjah Mada University,Indonesia

Abstract
Small beef cattle farming has not only important role to meet the need of meat in Indonesia, but also its important to life of 5,736 million farm households in Indonesia. Population of beef cattle by tenure based on national data in 2011, there were 10.96 million heads (73.95%) owned and operated by farmer and remains 4.34 million heads (26.04%) operated by other parties (PSKS, 2011). This study investigated the level of technical efficiencies and the determinants of inefficiency among Bali cattle (*Bos sondaicus*) fattening farm which rearing by farm-household owner and tenant under the system of share cattle-fattening (*Gaduhan Ternak)* in Muaro Jambi District, Jambi Province. Structured questionnaires were used to collect data from 34 owner and 40 tenant farm-households, which was selected by purposive sampling method. Sample of cattle fattening farm households had been analyzed with Stochastic Frontier Production function with Maximum Likelihood Estimate Method. The results of the study showed that the estimated level of technical efficiency of production on cattle fattening operated by owner were 0.789, while by tenant livestock were 0.631. Inefficiency model of cattle fattening operated by owners, indicated that: 1) fattening period and 2) age of the farm household's head had positive significant effects on technical efficiency. The other results show that: 1) age of farm household head's, 2) education level of farm household head's and 3) both the livestock share arrangement (on 70:30 basis and on 60:40 basis of produces); had significant and positive impact on technical efficiency, while 1) share food crop income to farm household incomes and 2) labor wage had significantly negative impact on inefficiency model of cattle fattening operated by tenants. Nevertheless, there are existences of inefficiency for both farm household owner and tenant livestock, but there are the ample opportunities to increase of productivity through improvements in their technical efficiency primary by increasing the number of forages.
Keywords: share cattle-fattening, technical efficiency, beef cattle

1. Introduction

Demand of beef is increasing according to the increasing of population, income, the level of welfare and public awareness of balance nutrition. More than 90% of local beef supply derived from smallholder farmers with a relatively slow in growth (Widayati, 2014). While base on PSKP (2011), almost 97.97% of beef cattle farms in Indonesia carried out by farm household in rural areas. Therefore small beef cattle farming are playing important roles to produce enough meat to achieve nation demand and increase farmer income and welfare.

One of the government policies in livestock development program to achieve self-sufficiency in meat in 2014 were deployment program of beef cattle in the rural areas and providing leasing in the form of livestock to farm-households by share-cattle fattening system (*gaduhan ternak*) (SK Menteri Pertanian No.146/Kpts/HK.050/2/93). Based on data at Muaro Jambi District, from 12.669 heads beef cattle, there were (see Figure.1.) about 8.082 heads (64%) owned and rearing by farmer and remains 4.587 heads (36%) rearing by other parties (*penggaduh*).



Sources Of Cattle	Heads
Government Loans	949
Private Loans	4
Share-livestock	3380
Others	254
Total	4587

Figure 1.Population Beef Cattle by Tenure In Muaro Jambi District.
Sources : PPSK, 2011

In the rural communities at Jambi Province there are other parties who play as investor or lease beef cattle to farmer under predetermined contractual arrangement. The first party (who own livestock) leases out his livestock to a tenant (as a second party), and the contractual arrangement between 2 parties decided to have benefit sharing on the production (share on 50:50%; 60:40% on basis production).

Simatupang *et al*. (1994), suggest that there are several factors that may encourage the presence share-cattle or "*gaduhan ternak"* in rural areas, such as: low income of farm-household and underdeveloped financial institutions in rural. Viewed from a principal agent perspective, Knoeber (2000) argues that all contracts in land

tenancy and contract production of livestock are formed because the parties involved expect to benefit. Further, viewed theory of share-tenancy in agriculture context, many economists have argued that share-tenancy causes inefficiency resource allocation. Puig-Junoy and Argiles (2000) show that farms in Spain with a large proportion of rented land have low efficiency. Different with the available empirical evidence on the efficiency of land tenure contracts (Otsuka and Hayami, 1988) where the majority of studies do not find significant inefficiency of share-tenancy.

Kumbhakar and Battachury, (1992) argue that there are various socio economic, demographic, institutional, environmental factors and non-physical factors that effect on efficiency, such as gender, age, educational level, household size, experience in farming, hybrid seed, access to credit, off farm work, membership of a farmer based organization, mono cropping, land tenancy and so on (Tesfay *et al*. 2005; Tchale and Suaer, 2007). Many previous empirical studies have focused on technical efficiency of beef cattle (Trestini, 2006, Krasachat, 2008; Fleming *et al*. 2010; Otieno *et al*. 2012; Isyanto *et al*. 2013; Ozden and Armagan, 2014; Bahta, 2014; Taubadel and Saldias, 2014). However, a few researches had been done on the technical efficiency of beef cattle fattening on farm-household owners and tenants. It is necessary to know the technical efficiency level of owners and tenant operate.

2. Theoretical Framework

Technical efficiency applied in the microeconomics of production is the maximum attainable level of output for a given level of production inputs, the range of alternative technologies available to the farmer. The Stochastic Efficiency Frontier (SPF) models according to Bettese and Coelli (1995) was used to estimate technical efficiency in Bali cattle (*Bos sondaicus*) fattening farm which rearing by farm-household owners and tenants.

The general of the stochastic efficiency frontier production function is defined by:

$$Yi = \exp(Xi\,\hat{a}i + Vi\text{-}Ui) \qquad (1)$$

where: Yi = observer output for the i-th beef cattle fattening in (kg) ; Xi = is vector of value of known function of inputs of production (number of feed forage, number of feed additional, veterinary service, family labor, spacious cowshed); $\hat{a}i$ = is a vector of unknown parameters to be estimated; the Vi= random errors; Ui = non-negative random variables, associated with technical inefficiency of production.

While Jondrow *et al*. (1982) measured the level of technical efficiency (TE) using adjusted output as allow:

$$Y^{*}=f(Xi\,\hat{a}i) - Ui \qquad (2)$$

Ui can be estimated as:

$$E(Ui/\hat{a}) = \frac{\ddot{a}\ddot{e}\left[F^{*}(\ddot{a}i\ddot{e}/\ddot{a}) - \ddot{a}i\ddot{e}\right]}{1+e^{2}\left[1-F^{*}(\ddot{a}i\ddot{e}/\ddot{a}) - \ddot{a}\right]}$$

where: F (*) = standard normal density function; F (*) = cumulative distribution functions

$\ddot{e} = \ddot{a}u/\ddot{a}v$ $\ddot{a}i = Vi\text{-}Ui$ $\ddot{a}_2 = \ddot{a}v_2 + \ddot{a}u_2$

V* = the observed output adjusted for statistical noise; while $\ddot{a}i$, $\ddot{a}$ and $\ddot{e}$ estimates were replaced in Equation (2) and (3); the estimated of Vi and Ui is obtained.

3.Research Methodology

Data for this study was derived from the observation on 74 farm-households who rearing Bali cattle (*Bos sondaicus*) fattening farm which is consist of 34 farm-households owners and 40 tenants beef cattle under three group different predetermining contractual arrangement or share-cattle fattening arrangement (which share on 50:50%; 60:40%; 70:30% of base production). Technical efficiency applied in the microeconomics of production is the maximum attainable level of output for a given level of production inputs, the range of alternative technologies available to the farmer. The Stochastic Efficiency Frontier (SPF) models according to Bettese and Coelli (1995) was used to estimate technical efficiency in Bali cattle (*Bos sondaicus*) fattening farm which rearing by farm-household owners and tenants.

The samples of farm-households owners and tenants were selected purposively in two sub district which are production center of beef cattle fattening farming in Muaro Jambi district. Those sub-districts are Kumpe Ulu and Sungai Gelam. The respondent of Bali cattle fattening farm-households were selected for interview was taken by proportional sampling at three villages. One village in Sungai Gelam sub district (namely Tangkit) and two villages in Kumpe Ulu sub district (namely Kasang Pudak and Pudak).

The stochastic frontier model introduced by Betesse and Coelli (1995) and applied software FRONTIER 4.1. were applied to generate both the stochastic production frontier and the inefficiency model simultaneously.

The stochastic frontier production from farm household owner is follows:

$$\text{Log } Y_{1i} = \alpha_0 + \alpha_1 log X_{1i} + \alpha_2 log X_{2i} + \alpha_3 log X_{3i} + \alpha_4 log X_{4i} + \alpha_5 log X_{5i} + \ddot{a}_i \qquad (4)$$

where: Y_{1i}= output; represents body weight gain at farm household owner-i (kg); $\alpha_{0\text{-}5}$ = regression coefficient to

be estimated; X_1= number of feed forages (kg); X_2 = number of feed additional (kg); X_3 = veterinary service (times); X_4 = family labor (man-day); X_5 = spacious cattle cage (m^2); ä*i* = composite error term (v*i* – u*i*) ; (u_{1i} = technical inefficiency effects in the model).

The stochastic frontier production from farm-household tenants is follows:

$$\text{Log } Y_{2i} = \beta_0 + \beta_1 log X_{1i} + \beta_2 log X_{2i} + \beta_3 log X_{3i} + \beta_4 log X_{4i} + \beta_5 log X_{5i} + ä i \quad (5)$$

where: Y_{2i} = output; represents body weight gain at farm household tenant - i (kg); β_{0-5} = regression coefficient to be estimate; X_1 = number of feed forages (kg); X_2 = number of feed additional (kg) ; X_3 = veterinary service (times) ; X_4 = family labor (man-day); X_5 = spacious cattle cage (m^2). ä*i* = composite error term (v*i* – u*i*); (u*i* = technical inefficiency effects in the model).

The technical efficiency was measured by of farm-household owners and tenants beef cattle fattening farm success in producing maximum output from a given set as defined by Farell (1975).

Determinant of efficiency of farm-household owner (6) and tenant (7) are defined as:

$$TE_{oi} = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + e \quad (6)$$

$$TE_{ti} = \gamma_0 + \gamma_1 Z_1 + \gamma_2 Z_2 + \gamma_3 Z_3 + \gamma_4 Z_4 + \gamma_5 Z_5 + \gamma_6 Z_6 + \gamma_7 Z_7 + \gamma_8 Z_8 + \gamma_9 Z_9 + e \quad (7)$$

where: TE_{oi} = Technical efficiency of the-i farm-household owner; TE_{ti} = Technical efficiency of the-i farm-household tenant; Z_1= Fattening Period (month); Z_2 = Age of the farm household head's (years); Z_3= Education of farm household head's (years); Z_4= experience in cattle farming (years); Z_5= Number of cattle (UA); Z_6 = Share food-crop income to total farm household income (%); Z_7 = Labor wage (Rp); Z_8 =Share based on production (dummy, = 1 if 70:30; = 0 if other wise); Z_9= Share based on production (dummy,= 1 if 60:30; = 0 if 50:50) ; *e* = error term ; δ_0,γ_0 = intercept; ; δ_1-δ_7 = parameter to be estimated; γ_1-γ_9 = parameter to be estimated.

4.Results and Discussion

4.1Maximum Likelihood Estimate of Stochastic Frontier Production Function

The result of Maximum Likelihood Estimation (MLE) for production function had described in equation (4) and (5) which is reported in Table 1. The results of estimation of production function of beef cattle fattening operated by farm-household owners revealed that number of forages and spacious cattle cage have positively significant at 5 % and 1% levels, respectively. These mean that increasing of those variables by 1% will increase output about 0.213% and 0.260%, respectively. Other results showed that the number of additional feed (rice bran) and number of veterinary service although had positive effect but those had no significant effect even at 15% the level of significance.

Table 1. The MLE of Stochastic Frontier Production Function for Bali Cattle-fattening Operate by Farm-household Owner and Tenant in Muaro Jambi District Jambi Province.

Variable	Farm household Owner	Farm-houehold Tenant
Production Function		
Constant	2.073 (2,447)***	0.849 (0.992) ns
Number of forages	0.213 (2.130) **	0.249 (3.390) ***
Number of additional feed	0.085 (0.992) ns	0.132 (1.868) *
Number of veterinary services	0.004 (0.276) ns	0.013 (0.164)ns
Number of family labor	0.232 (1.390) ns	0.393 (1.983) *
Spacious cattle cage	0.260 (3.902) ***	0.109 (1.377)ns

Notes: *) sign on α = 15 % (1.485); **)sign on α = 5 % (2.059) ; ***)sign on α = 1 % (2.287)

The results of the estimated production function of beef cattle fattening operate by tenants (see table.1), showed that all the coefficients of the input variables conform to a priori expectation of a positive signs. The coefficient of variables number of forages, number of additional feed (rice bran) and number of family labor were positive and significant at 1% and 15 % levels. These implies that increasing number of forages, number of additional feed and number family labor by 1% will lead to increase about 0.249%, 0.132% and 0.393 % in output of beef cattle fattening. While the coefficient of variables of number of veterinary service and spacious cattle cage though positive, but statistically not significant even at 15 % level of significance.

4.2Determinants of Inefficiency Beef Cattle Fattening Farm operate by Farm Owners and Tenant

The result from the determinants of inefficiency of Bali cattle fattening operate by owner and tenants productions (see Table. 2) shows that the sigma square of Maximum Likelihood Estimation of beef cattle-fattening production from farm-household owners and tenants were 0.010 and 0.014; and statistically significant at the 1% level. That indicates a goodness of fit and correctness of the specified distribution assumption of the composite error term. The estimated value of the parameter (γ) in both of farm-household owners and tenants were 0.999 and significant at the 1% level. These results indicate 99% variation of the production level, both on beef cattle-fattening was caused by differences in technical efficiency, while 1% was caused by variables outside the control of farmer or measurement error. The generalized likelihood ratio test 71.57 and 40.91 are statistically significant at the 1% level indicating the presence of a one sided error component. farmer or measurement error.

Table 2: Determinants of Inefficiency of Bali Cattle Fattening operate by Farm house-hold Owner and Tenants in Muaro Jambi District Jambi Province

Variable	Operated by Owner		Operated by tenant	
Inefficiency Function	Coef.	t-ratio	Coef.	t-ratio
Constant	0.987 ***	3.173	0.710 *	1.567
Fattening period	- 0.001 **	- 2.046	- 0.004 ns	- 0.130
Age of farm-household head	- 0.005 *	- 1.494	- 0.009 *	- 1.698
Education level of farm-household head	- 0.016 ns	- 1.172	- 0.030 *	- 1.985
Experience in cattle farming	- 0.003 ns	- 0.004	- 0.011 ns	- 1.126
Number of cattle	0.021 ns	0.218	- 0.140 ns	- 1.370
Share of crop income	- 0.003 ns	- 0.004	0.600 *	2.002
Labor wage	0.060 ns	0.232	0.000 **	2.345
dummy 70:30			- 0.157 *	- 1.555
dummy 60:40			- 0.370 ***	- 2.806
Sigma Square	0.010***	3.398	0.014**	2.420
Gamma	0.999***	34.951	0.999***	81.234
Log like hood function	67.42		35.82	
LR Test	71.57		40.91	

Notes: *) sign on α = 15 % (1.485); **)sign on α = 5 % (2.059); ***)sign on α =1 % (2.287)

The estimated coefficient of the inefficiency function provides some explanations for relative technical efficiency level. The coefficient of fattening period and age of farm-household heads have significant and positively effect on the level of technical efficiency of cattle fattening farming operated by farm-household owner models. This implies that efficiency of farm-household owner's will increase with increasing of fattening period and age of farm-household head.

Related to explain the variable of fattening period, the most of cattle fattening farming operate by owners used calves with ages 7-8 month and sold at the age of 20-23 month (average fattening period is 14 month). While tenants used cattle in the age of 12-13 month and sold at the age of 23-24 month (average fattening period is 11 month). Using of calves (7-8 month) on farming operated by owner beside cause fattening period is more longer and using calve with little size had negatively effect to efficiency.

Related to the age of farm household head's, it's believed that age can serve as a proxy for farming experience. Hence the older age, the greater of the farming experience a farmer has. Farmers with more experience will able to manage the use of all available production factors efficiently, so that is increasing of technical efficiency. This result is consistent with the findings of Trestini (2006) and Isyanto *et al*. (2013). The estimated of the variable of the share cattle fattening arrangement (on 70:30% and on 60:40% of production) had significant and negative impact for technical efficiency. This suggests that farmers with share-cattle fattening arrangement on 70:30 basis on production achieved higher levels of technical efficiency than 60:40. The same interpreted that the share-cattle fattening on 60:40 based on production achieved more higher than share-cattle fattening on 50:50 based on production. These result shows that the increasing of large share received by tenant will improve technical efficiency.

The estimated of the parameter the share of income from food crop production to total farm-household income had significant and negatively effect on the level of beef cattle technical efficiency in farm-household tenant. This means that the increase of share of income from food crop production will reduces technical efficiency. The farm-household is assumed to maximize its utility function subject to production function, time, and income constraints (Barnum, 1978). Farm-household tenant income consists of on-farm income (food-crop, livestock, etc), off-farm income, and income from non-agricultural sector. At the time livestock income cannot meet the need of farm-household consumption, then farm-household will allocate of family labor inputs prefers to food-crop production than beef cattle fattening production activities. Related in this context, the decreasing of family labor supply on beef cattle fattening will imply a negative impact on technical efficiency because there are a competitive correlation among allocation of family labor inputs between food-crop production and beef cattle fattening production activities.

The estimate of the parameter for wage labor variable had significant and negatively effect on the level of technical efficiency on beef cattle fattening farm operated by tenant, while in beef cattle farming operated by owner had no significant effect. The value of family labor (opportunity cost of labor) which is received by farm-households tenant is the amount of received part of the share cattle-fattening arrangement. The increasing of wage labor in that is bigger than the share of cattle fattening will effect on allocation working time on beef cattle fattening production. It will cause negative effect on technical efficiency.

The mean of technical efficiency for the sample of beef cattle farm household owner was estimated at 78.90 percent, with varied from 52.9-99.9. While the farm-household tenant estimated at 63.16 percent, with varied

form 35.3-99.9.

Table 3. Frequency Distribution of Technical Efficiency

Efficiency	Farm-Household Owner		Farm-Household Tenant	
	Frequency	%	Frequency	%
< 0.40	0.00	0.00	2.00	0.05
0.40 < ET < 0.50	0.00	0.00	11.00	27.50
0.50 < ET < 0.60	1.00	2.94	7.00	17.50
0.60 < ET < 0.70	9.00	26.47	6.00	15.00
0.70 < ET < 0.80	11.00	32.35	3.00	7.50
0.80 < ET < 0.90	5.00	14.71	9.00	22.50
0.90 < ET < 0.99	8.00	23.53	2.00	5.00
Sum	34.00		40.00	
Mean	0.788		0.631	

The result of testing the equality of means of technical efficiency (see table 4) show that the technical efficiency farm-households owner performed significantly higher than farm-household tenant (t value 4.35, in a Sign. $p < .05$) (see table 4). It was interesting to note that the production of beef cattle-fattening which operate by owners was more technically efficient than tenant.

Tabel.4. T-test for Equality of Means Technical Efficciency

	t-test for Equality of Means						
Equal variances	t	df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	95% Confidence Interval of the Diff	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower
assumed	4.252	72.00	.000	.1569	0.036	0.083	0.230
not assumed	4.358	70.64	.000	.1569	0.036	0.085	0.228

5. Conclusion

The technical efficiency of Bali cattle fattening farming which operate by owner was 0.789 which was higher than that which operates by tenant that was 0.631. The major factors explaining of beef cattle fattening production operated by owner were number of forages and spacious cattle cage. While number of forage, number of additional feed and number of family labor were major factors that explaining of beef cattle fattening production from beef cattle fattening operate by tenant.

The result from the determinants of technical efficiency level of Bali cattle fattening operate by farm-household owner in models of inefficiency show that fattening period and age of farm-household head's, have significant and positively effect on the level of technical efficiency.

In other result on the models of inefficiency from farm-household tenants indicated that: 1) age of head of farm-household's, 2) education level of farm-household head's, 3) and both the livestock share arrangement (share on 70:30 and 60:40 based of production); had significant and positive impact on technical efficiency, while share of food-crop income and labor wage, had significant and negatively effect on technical efficiency.

Specific conclusion of the study is the level of technical efficiency in small beef cattle production is not only affected by the ownership of the livestock but also affected by the proportion of part that is received by farm-households tenant from share-cattle fattening. The increase proportion of share based on production that is received by tenant, the level of technical efficiency will be increased.

6. Recommendation

There are still rooms for improving technical efficiency by small beef cattle fattening operate by farm-household owners and tenants to fully utilized existing inputs. Particularly related to livestock development program in the form of share-cattle systems for technical efficiency improvement, the policy maker should focus on improvement of forage technology of beef cattle fattening farming.

References

Baittese, G.E. & Coelli, T.J. (1995), "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function", *Journal Empirical Economics* 20, 325-332.

Barnum and Howard Nelch. (1978), "An Economics Application of The Theory Of The Farm-Household Model", *Journal of Development Economics* 6 (1979), 79-102. 0

Batha, S. (2014), "Technical Efficiency in Beef Cattle Production in Botswana: A Stochastic Metafrontier Approach," Tropentag, September 17-19, 2014, Prague, Czech Republic.International Livestock Research Institute (ILRI), Botswana.

Fleming, E. Fleming, P. Griffith, G. and Johnston, D. (2010), "Measuring Beef Cattle Efficiency in Australian Feedlots: Applying Technical Efficiency and Productivity Analysis Methods". *Australasian Agribusiness Review* (8). Paper 4.

Isyanto, AY. Iksan, M.S. Hanani, N. Syafrial, (2013), "Measurement of Farm Level Efficiency of Beef Cattle Fattening in West Java Province Indonesia", *Journal of Economics and Sustainable Developmen*t (4), 10.

Jondrow, J.C.K. Lovell, M. and Schmidt, P. (1982), "The Estimation of Technical Inefficiency in Frontier Stochastic Production Function". *Journal of Econometrics*, 19. 233-238.

Knoeber, C. R. (2000), "Land and Livestock Contracting in Agriculture: A Principal-Agent Perspective". *Encyclopedia of Law and Economics,* Vol. III, (1) 133-153.

Krasachat, W. (2008) , "Livestock Production System and Technical Inefficiency of Feedlot Cattle Farms in Thailand". *Chulalongkorn Journal of Economics,* 20(2).

Kumbhakar, S.C. & Bhattacharya, A. (1992), "Price Distortion and Resource Use Efficiency in Indian Agriculture: A Restricted Profit Function Approach"*, Review of Economics and Statistics*, 74. 231-239.

Otieno, D. J. and Hubbard, Lionel J. and Ruto, Eric, (2011), "Technical Efficiency and Technology Gaps in Beef Cattle Production Systems in Kenya: A stochastic metafrontier analysis," *85th Annual Conference,* April 18-20, Warwick University, Coventry, UK 108947, Agricultural Economics Society.

Otsuka, K. & Y. Hayami, (1988), "Theories of Share Tenancy: a critical survey". *Economic Development and Cultural Change* 37. 31-68.

Ozden, A. & Armagan G. (2014), "Efficiency Analysis On Cattle Fattening In Turkey", *Veterinarija Ir Zootechnika (Vet Med Zoot)* . T. 67 (89).

PSKS (2011), "Pendataan Sapi Potong, Sapi Perah dan Kerbau 2011", Badan Pusat Statistik dan Direktorat Jenderal Peternakan dan Kesehatan Hewan.

.Puig, J. & Josep, M. Argilés (2000), "Measuring and explaining farm inefficiency in a panel data set of mixed farms", *Economics Working Papers,* 503. Department of Economics and Business, Universitat Pompeu Fabra.

Simatupang, P. Jamal, E. and Togatorop, M.H. (1994), "Sistem Gaduhan Sapi Tradisional Bali: Faktor Pendorong, Penopang dan Karakteristiknya". *Forum Penelitian Agro Ekonomi*, Vol.12. Pusat Penelitian Sosial Ekonomi, Badan Litbang Pertanian.

Taubadel, S von C & Saldias, R. (2014), "Access to credit and determinants of technical inefficiency of specialized smallholder farmers in Chile". *Chilean Journal of Agricultural Research* 74 (4) Oct-Des.

Tchale, H. & Suaer, J. (2007). "The Efficiency of Maize Farming In Malawi: A Bootsrapped Translog Frontier". *Cahiers d'economie et sociologie rurales*, no.82-83

Tesfay, G. Ruben, R. Pender, J. & Kuyvenhoven, A. (2007), "Resource Use Efficiency On Own And Sharecropping Plots In Northern Ethiopia: Determinants And Implications For Sustainability". Sustainable Poverty Reduction in Less-Favoured Areas 2007 pp. 181-202.

Trestini, S. (2006), "Technical Efficiency of Italian Beef Cattle Production Under a Heteroscedastic Non-neutral Production Frontier Approach". In: Conference on Food, Agriculture and the Environment 10, Minnesota, pp: 1-18.

Widiati. R. (2012). "Financial Feasibility of Beef Cattle Breeding with Various Capital Aid in Rural Area of Gunung Kidul District of Yogyakarta". *Buletin Peternakan.* Vol 36 (2) : 122-128